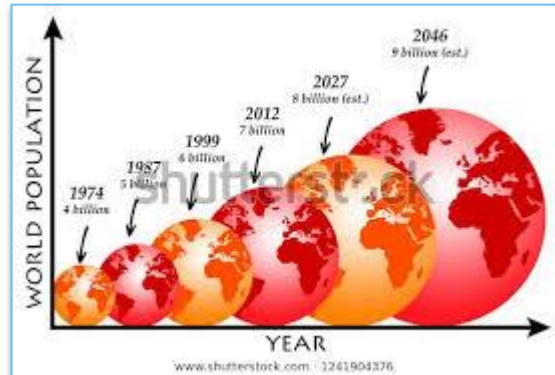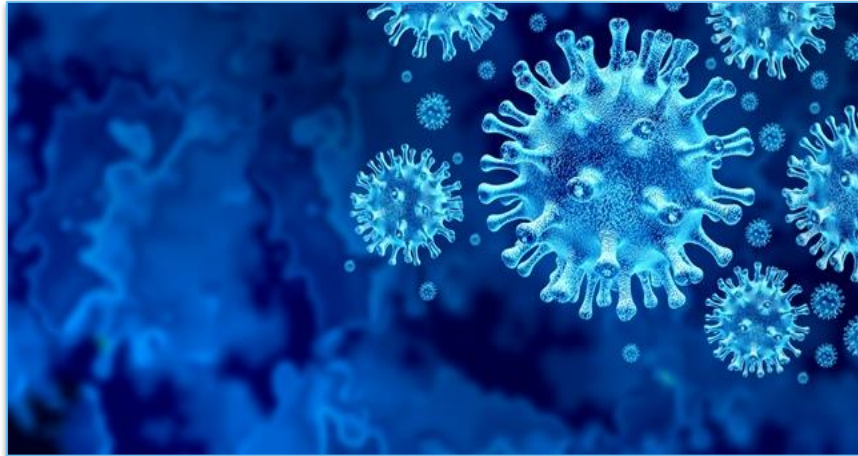# Fast changing world

Our experience – manufacturer, user, trainer
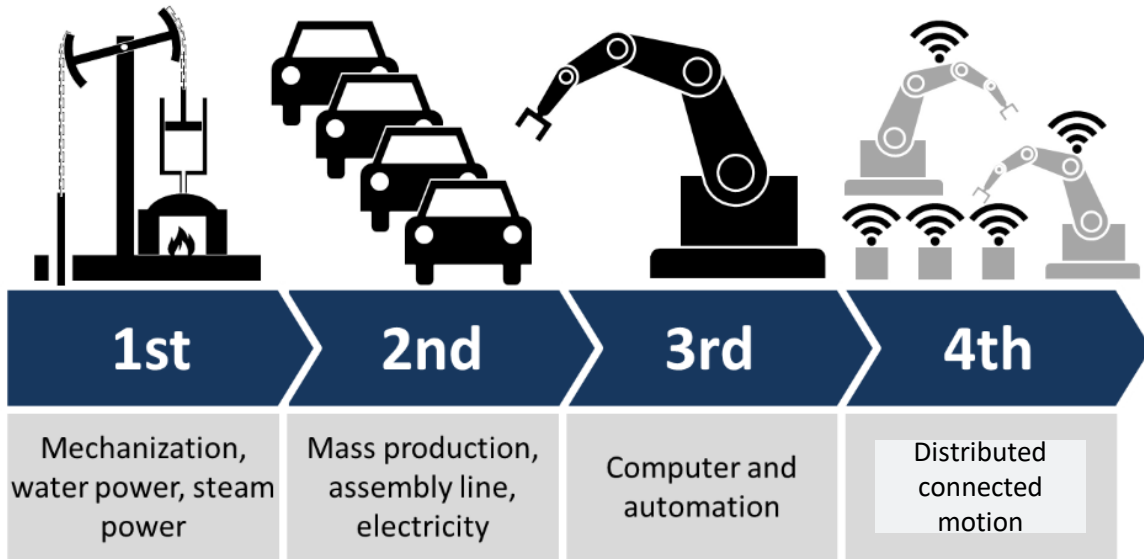
Festo is a large scale manufacturer with production sites all over the world, we are in the same position as other manufacturers

- Climate Action
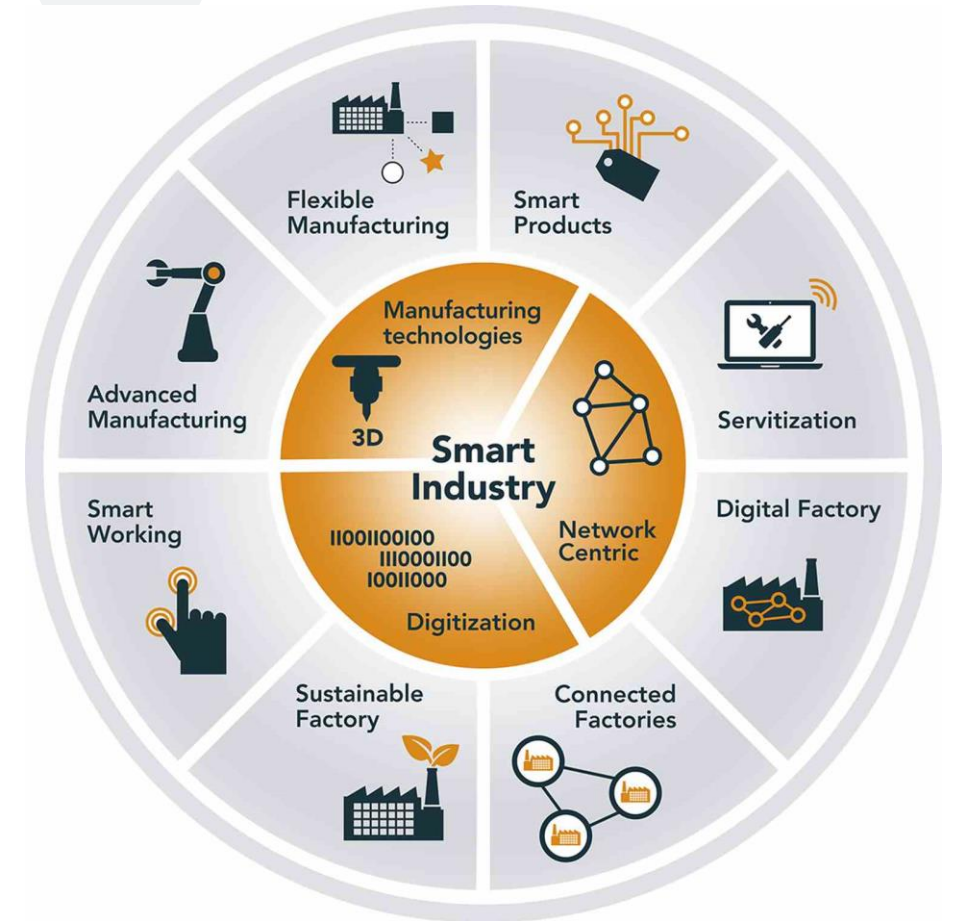- Quality Education
- Responsible Consumption and production.

Industry 4.0

Digitalization and Internet of Things

By Christoph Roser at AllAboutLean.com under the free CC-BY-SA 4.0 license

1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Distributed connected motion

| Conceptualise | Design | Procure | Assembly | Operate | Maintenance |

Administration shell

eCl@ss — Part classification and product description

"Common language for I4.0" according ISO/IEC Product comparison B2B
Standardized description of product features (system independent data sheet)

eCl@ss Classification and Product description (Example)

IRDI = International Registration Data Identifier

Part Engineering — <AutomationML/>

Digital Twin

Automation ML = Automation Markup Language = XML based data format for exchanging machine planning information

- Simulation
- Behaviour Description
- Electric eCAD
- Pneumatic
- Kinematic
- Mechanic MCAD

Quotation/Marketing/Distribution Exchange

XML ↔ JSON

Part Operation

OPC UA · MQTT

Part Artificial Intelligence

RDF

Quick Search Plus
- Finding product information

Handling dimensioning tool (HGO)
- Selection and simulation
- Choose type of handling system and enter your application data
- Simulation
- Solution proposals

Pneumatic Sizing
- Customising pneumatic control chains is quick and easy
- Enter: 3 application parameters
- Get: Up to 3 design versions matching the applications – precise, eco or performance

Process valve configurator
- Fast and simple project management
- Efficient procurement process
- Perfectly tailored products
- Including system ID and CAD download

Product Key
Printed on every product

Control cabinets configurator for process automation
Tailored to your ideas - One housing for infinite variety on the inside

Festo Design Tool 3D online
- 3D CAD-based configurator for pneumatic cylinder modules with accessories
- 80% time saving at the product selection and design process
- No installation needed – WebGL based
- CAD file formats and functions

2D/3D CAD Data
Get CAD data for your solution – free of charge
- Selection on Festo page
- Generation and supply via Cadenas PARTserver

Product configurators
Select your perfect fit solution among millions of solutions – pay only for the functions you need
- More than 400 configurators

Electric Motion Sizing
Select your electric motion solution among thousands of possibilities – with only a few
Import function · Festo Automation Suite

ePLAN Schematic Solution – GDDE
Electric circuits for ECAD integration – time saving

Fluid Draw
Create your pneumatic circuit – fast, easy, cost efficient

Configon
Web-based configuration framework for the error-free and user-friendly configuration of complex products

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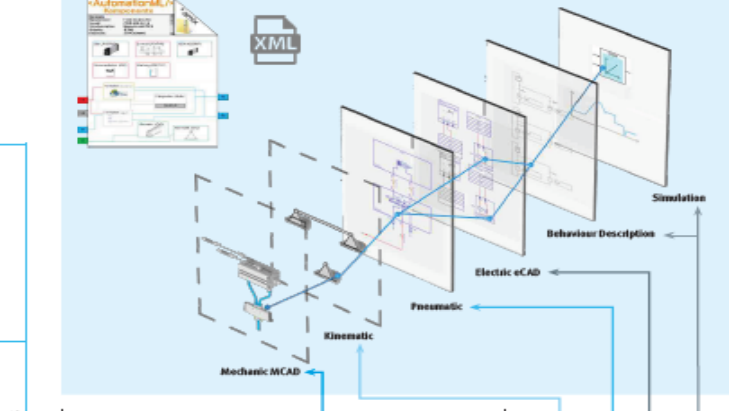
MCAD Graphical data 2D/3D
creo · SIEMENS NX · CI PART · SOLIDWORKS · Solid Edge · ptc · CATIA · AutoCAD · MegaCAD · DASSAULT SYSTEMES · AUTODESK INVENTOR · Onshape · AUTODESK · SIEMENS

ECAD Electrical data
EPLAN electric · WSCAD · ZUKEN · E3 series · eplan fluid · FESTO · eCATALOGsolutions

Pneumatic Hydraulic
eplan fluid · FESTO

PLC Program Engineering Software
OMRON · SIEMENS · Rockwell Automation · CODESYS · FESTO

Virtual commissioning
DELMIA · ISG · CIROS · SIEMENS

Smart Operation and Maintenance

Cloud Level

Infrastructure
Microsoft Azure · aws amazon webservices · Google Cloud · Alibaba Cloud · Tencent Cloud

Plattform
SIEMENS MindSphere

Application
Festo AX – The automation industry needs AI #higherproductivity by leveraging AI, IoT and Edge Computing Data analytics

Predictive quality
Improves overall production quality by continuously monitoring and analysing production data and detecting quality issues

Predictive energy
Optimises energy usage by continuously monitoring and analysing energy consumption as well as detecting anomalies

Predictive maintenance
Predicts failures and reduces unplanned downtime by continuously monitoring and analysing asset data

Smartenance
Supports all maintenance activities in a cloud-based application. Offers an API for seamless connectivity and a mobile app for the shop floor communication

- Manufacturer independent. One solution for the shop-floor
- Autonomous Maintenance
- Incident Management + Plant logbook

Machine Learning
Training · Evaluation · Anomaly Detection · Anomaly Localisation · Anomaly Classification

Key benefits:
- Overall Equipment Effectiveness improvement
- Reduce cost in maintenance

AI in the cloud:
- High computing power
- AI learning
- Forward looking actions

MQTT

On-Premises: MES, ERP
Rockwell Automation FactoryTalk
Festo Automation Suite

AI On-Premises:
- High computing power
- AI learning
- Forward looking actions

Field Level

Key benefits:
- Flexible products
- Quality increase

Time saving – One software for all:
- Start-up and commissioning
- All Festo products
- All levels
- All files and dokuments

AI On Edge:
- Real time
- Process controlling, monitoring and direct reaction (e.g. sorting out products)

OPC-UA · Modbus · S7 · HTTP · Festo CI/CP

AI = targeted analysis of the information and evaluation

Smart Products
- Sensor information are not routed 1:1
- Selection and filtering of information
- Communication and connectivity

Logic — Aggregate data

Field bus — Transport data

Field device — Collect data

Sensors — Raw data

Sensors are the source of information for Artificial Intelligence

Data volume/Sampling rate

- Machine
- Control Cabinet
- Handling

Learn – Didactic

Inspire – Bionic

What does "Digitalization" mean from an Automation Supplier point of view?

Smart Engineering and Commissioning

Conceptualise	Design	Procure	Assembly

Administration shell

eCl@ss — Part classification and product description

CLASSIFICATION AND PRODUCT DESCRIPTION

"Common language for I4.0" according ISO/IEC Product comparison B2B
Standardized description of product features (system independent data sheet)

→ eCl@ss Classification and Product descripton (Example) ▶

Classification					Description				
1st level	2nd level	3rd level	4th level	IRDI	Properties	IRDI	Value	IRDI	
51 – Fluid Power	03 – Valve	01 – Directional Control Valve	03 Standard valve electrically operated	0173-1#01-AGW550#001	Directional control valve function	0173-1#02-KAA110#001	5/2	0173-1#07-KAD562#001	

IRDI = International Registration Data Identifier

Quick Search Plus

- Finding product information

Handling dimensioning tool (HGO)

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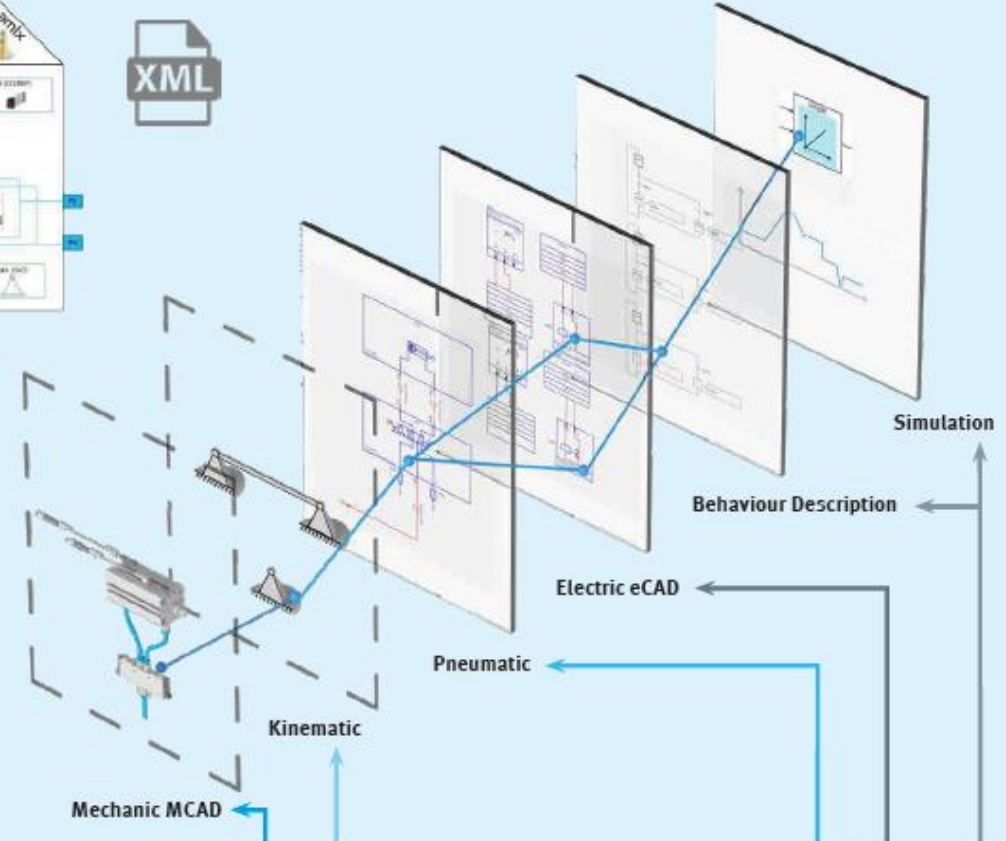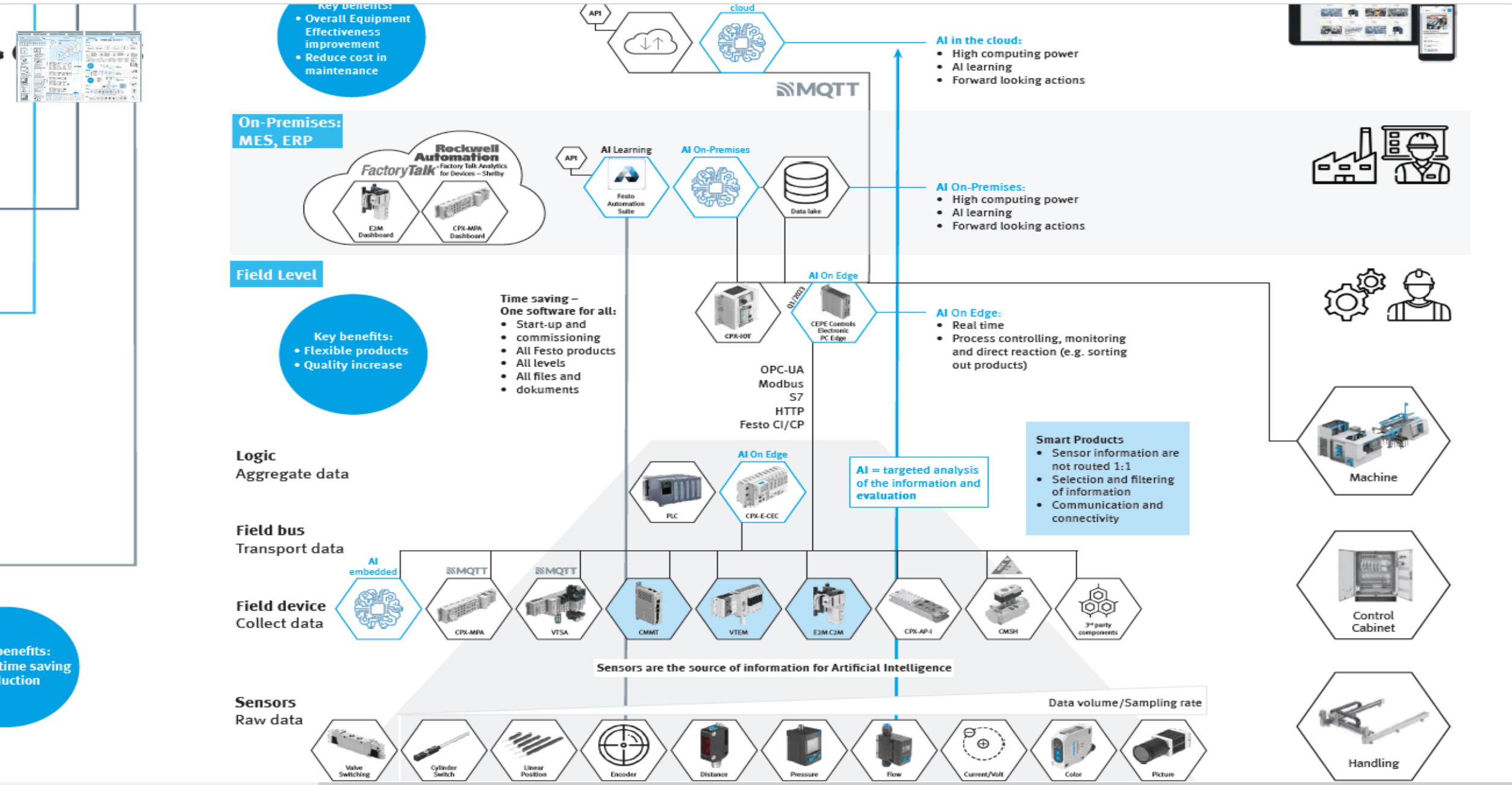
<AutomationML/>

Digital Twin

<AutomationML/> Komponente

XML

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Simulation

Behaviour Description

Electric eCAD

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cloud

API

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MQTT

On-Premises: MES, ERP

Rockwell Automation
FactoryTalk – Factory Talk Analytics for Devices – Shelby

E2M Dashboard

CPX-MPA Dashboard

AI Learning
Festo Automation Suite

API

AI On-Premises

Data lake

AI On-Premises:
- High computing power
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Field Level

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- All levels
- All files and
- dokuments

AI On Edge

CPX-IOT

01/2023

CEPE Controls Electronic PC Edge

AI On Edge:
- Real time
- Process controlling, monitoring and direct reaction (e.g. sorting out products)

OPC-UA
Modbus
S7
HTTP
Festo CI/CP

Logic
Aggregate data

AI On Edge

PLC

CPX-E-CEC

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- Communication and connectivity

Machine

Field bus
Transport data

AI embedded

MQTT

MQTT

Field device
Collect data

CPX-MPA

VTSA

CMMT

VTEM

E2M C2M

CPX-AP-I

CMSH

3rd party components

Control Cabinet

Sensors are the source of information for Artificial Intelligence

Sensors
Raw data

Data volume/Sampling rate

Valve Switching

Cylinder Switch

Linear Position

Encoder

Distance

Pressure

Flow

Current/Volt

Color

Picture

Handling

benefits:
time saving
uction

What does "Digitalization" mean from an Automation Supplier point of view?

Assembly	Operate	Maintenance

Administration shell

...eering

<AutomationML/>

...kup Language = XML based data format
...nformation

Simulation

Behaviour Description

Electric eCAD

...Pneumatic

Quotation/Marketing/ Distribution Exchange

XML ⟷ JSON

Part Operation

OPC UA **MQTT**

Part Artificial Intelligence

RDF

Cloud Level

Infrastructure

Microsoft Azure

aws amazon web services

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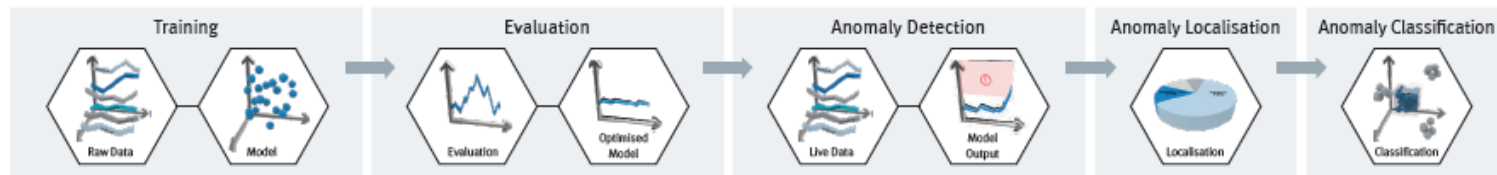
Training	Evaluation	Anomaly Detection	Anomaly Localisation	Anomaly Classification
Raw Data / Model	Evaluation / Optimised Model	Live Data / Model Output	Localisation	Classification

- Manufacturer independent. One solution for the shop-floor
- Autonomous Maintenance
- Incident Management + Plant logbook

Key benefits:
- Overall Equipment Effectiveness

API

AI in the cloud

CADENAS PART

ptc

Focus in this presentation

Industrial Internet of Things: Digital Twin, IoT, Cloud, Services, Solutions

FESTO

Learn - Didactic

Inspire - Bionic

Smart Engineering & Commissioning

Smart Operation & Maintenance

Conceptualise	Design	Procure	Assemble	Operate	Maintain and Modernise

Projects — Enabler for department and company **collaboration**

Component Life Cycle Management

Administration shell

product description	Engineering	Quotation, Marketing	Operation	Artificial Intelligence
eCl@ss — CLASSIFICATION AND PRODUCT DESCRIPTION	<AutomationML/>	XML ↔ JSON	OPC UA	RDF

Festo design, selection and engineering tools
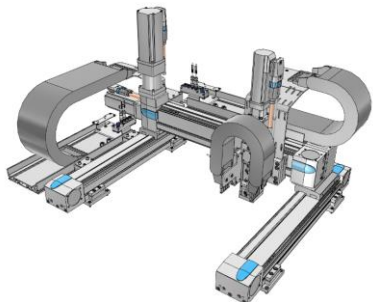
Digital Twin
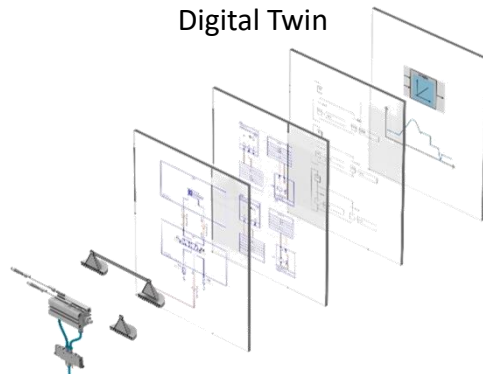
Cloud Level

On-Premise — Festo Automation Suite

Field Level

Start-up and commissioning

Ind. Internet of Things

Artificial intelligence

6

Quality Education

Electricity and Electronics

IIoT and Industry 4.0

Industrial Trades

Building System Technology

Electric Power Technology

Factory Automation

Renewable Energy

Fluid Power

Communication and Radar Technology

Metal Working
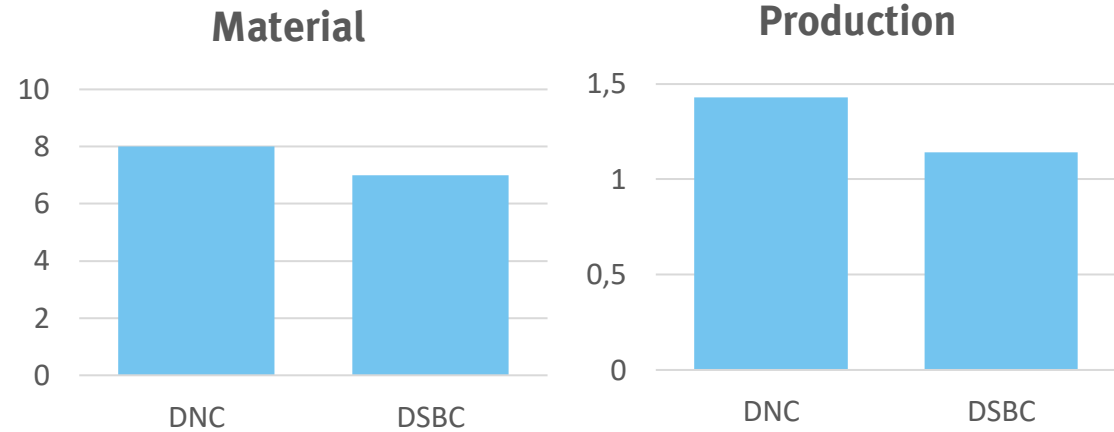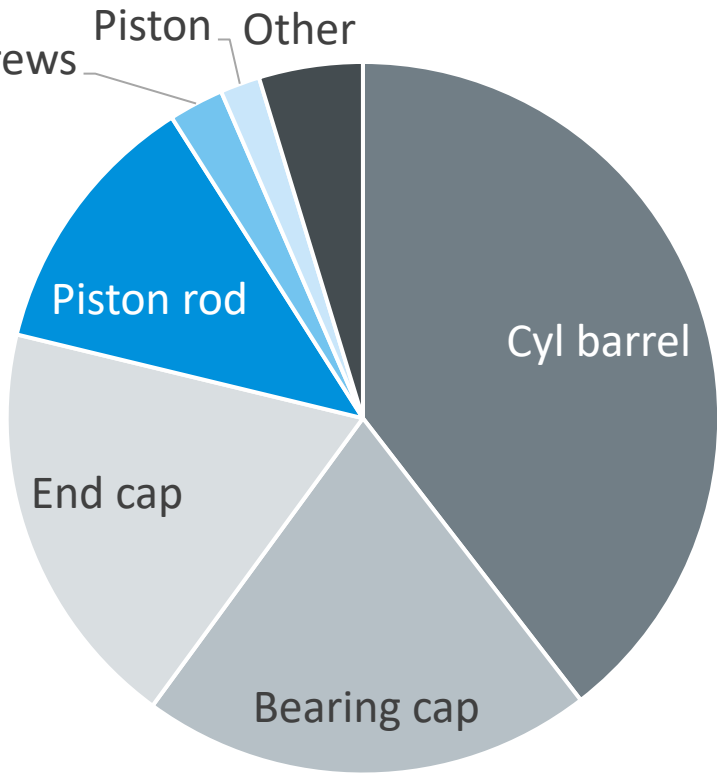
Process Automation

and more

FESTO

Conceptualize

Handling Guide Online
Standard Handling Systems with Handling Guide Online

Design - based on sustainability

Increasing the visibility of energy consumed in the manufacture and use of automation components

FESTO

Analysis of CO_2 consumed in the manufacture of a pneumatic cylinder

Pie chart labels: Cyl barrel, Bearing cap, End cap, Piston rod, Screws, Piston, Other

Old

DNC

New

DSBC

Material

DNC   DSBC

Production

DNC   DSBC

14% overall saving of CO_2 equivalent

Focus on energy consumption in production

- **Energy prices are soaring**

- High fluctuations and fast moving energy market

- Law and governance bearing down on energy consumption

- Consumers and shareholders demanding CO_2 / energy reduction

- Corporate Social Responsibility to reduce CO_2 footprint

Pressure from shareholders and other stakeholders on boards, leaders and managers translates into pressure on the shoulders of maintenance, energy and utility managers.
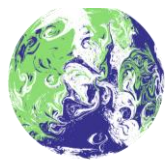
Gas Prices: Forward Delivery Contracts – Weekly Average (GB)

Electricity Prices: Forward Delivery Contracts – Weekly Average (GB)

Information correct as of: March 2022

Source: Ofgem - Office of Gas and Electricity Markets

How can you reduce your compressed air energy consumption?

FESTO

Develop maintenance engineering and operators' energy reduction skills

Regular energy audits and improvement programmes

Training & Consulting

Engineering

Products & Solutions

Services

Improved specification for purchasing new machines

Selecting the most energy-efficient technology and more energy-efficient products

Utilise latest energy management systems supported by machine learning (AI)
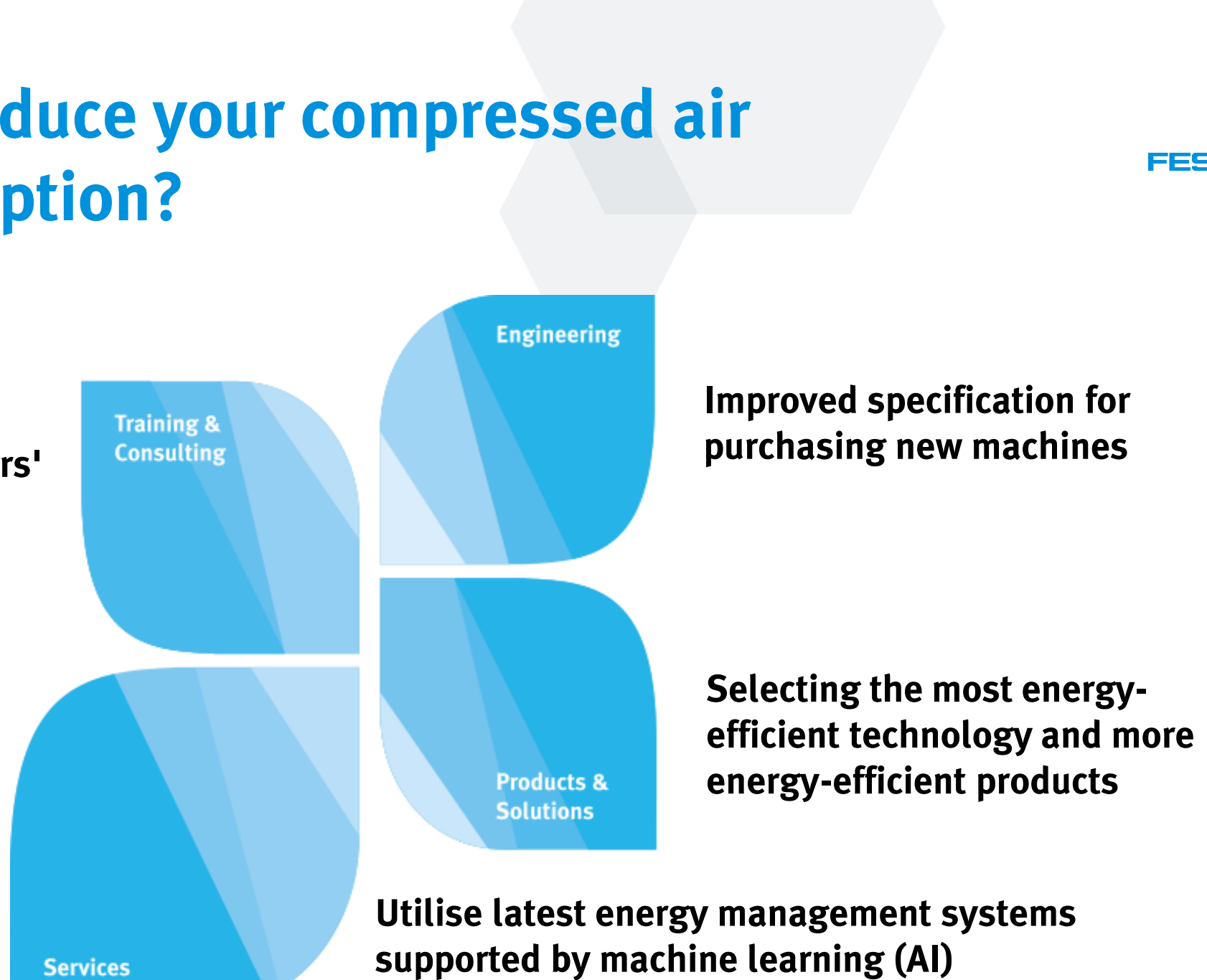
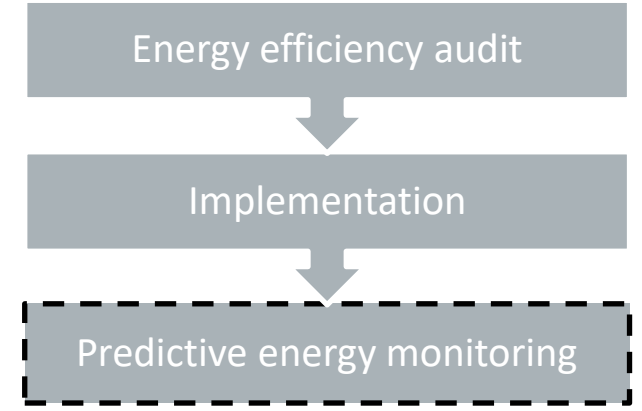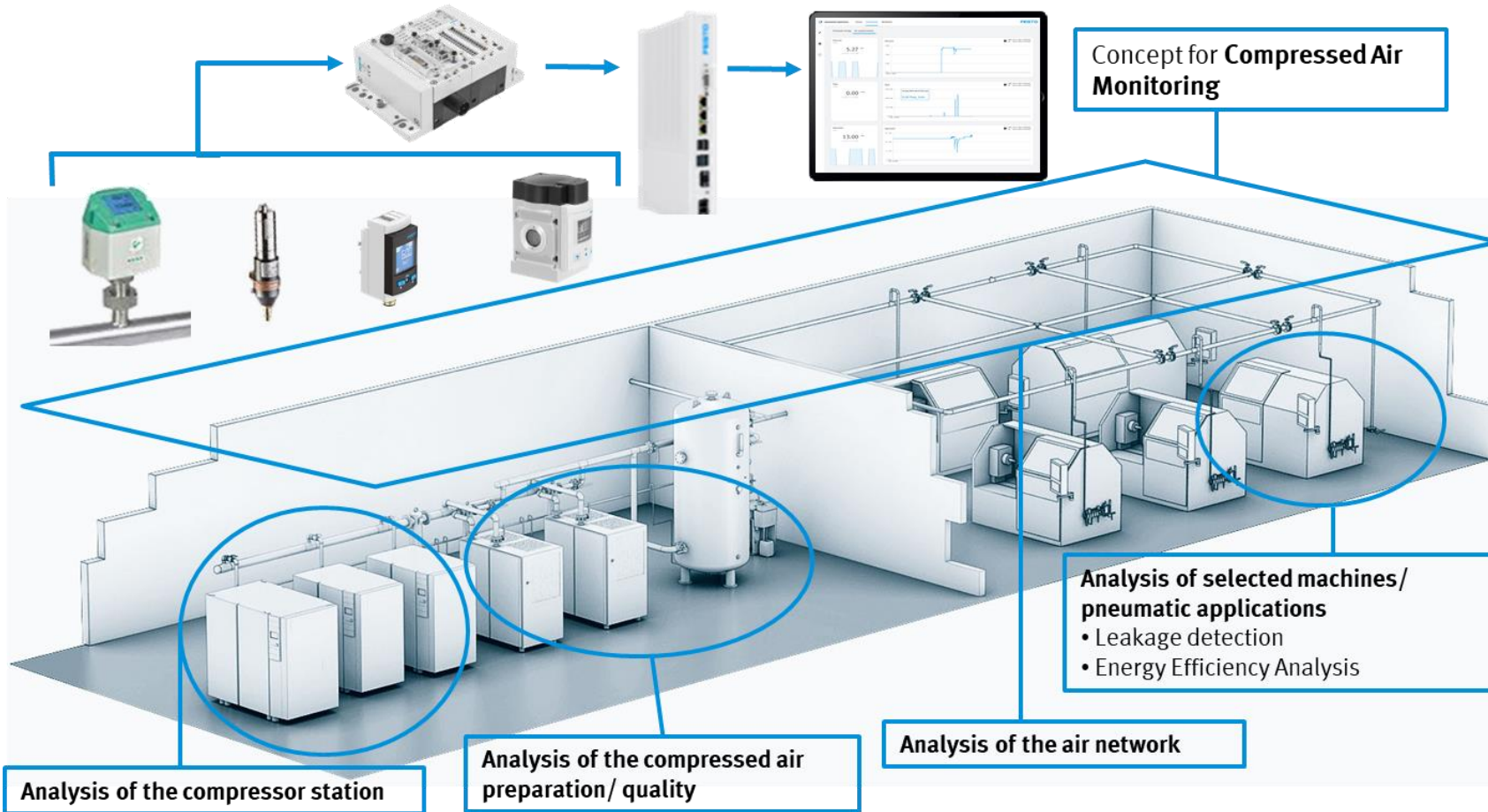# Utilising the latest energy management systems supported by machine learning (AI)

FESTO

Festo Automation Experience

Continuous monitoring and analysis of relevant data for anomaly detection to optimise production
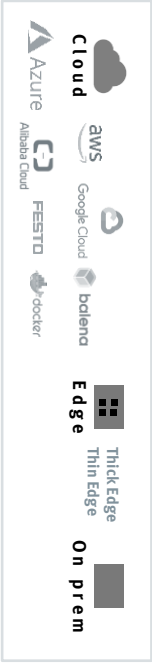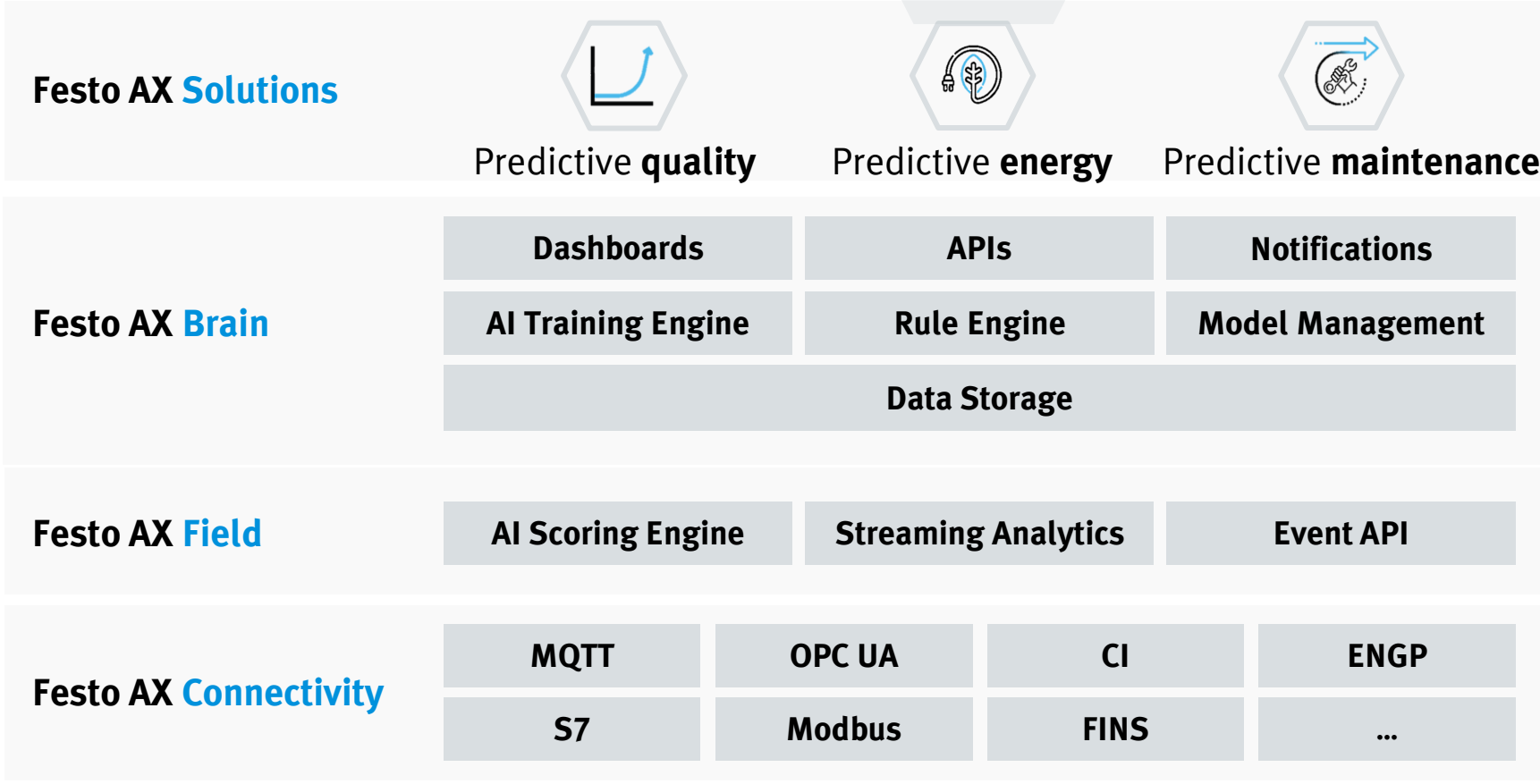
Festo AX – The automation industry needs AI

Predictive energy – Continuous energy consumption monitoring and anomaly detection to optimise energy usage

Concept for **Compressed Air Monitoring**

Energy efficiency audit

Implementation

Predictive energy monitoring

Analysis of selected machines/ pneumatic applications
• Leakage detection
• Energy Efficiency Analysis

Analysis of the air network

Analysis of the compressed air preparation/ quality

Analysis of the compressor station

Overview - Festo AX Architecture

FESTO

Festo AX Solutions	Predictive **quality**	Predictive **energy**	Predictive **maintenance**

Festo Automation Experience

Festo AX Brain

Dashboards	APIs	Notifications
AI Training Engine	Rule Engine	Model Management
Data Storage		

Festo AX Field

AI Scoring Engine	Streaming Analytics	Event API

Festo AX Connectivity

MQTT	OPC UA	CI	ENGP
S7	Modbus	FINS	...

Cloud — Azure, Alibaba Cloud, aws, FESTO, Google Cloud, Docker, balena

Edge — Thick Edge / Thin Edge

On prem

What is Machine Learning?

Example: Anomaly Detection and Classification

1. Training

Raw Data   Model

The model is adjusted to data with a learning/training algorithm

2. Evaluation

Model Evaluation   Optimized Model

Optimization of model quality by adjusting meta parameters

3. Anomaly Detection

Live Data   Model Output

Analysis on Real Time Data

4. Anomaly Localization

Pressure
76 %

Reaction Time
17 %

5. Anomaly Classification

Membrane tear
in valve

Bearing
damage

Cylinder
friction

Predictive Energy in Food & Packaging

Industry:

Food (Filling)

Benefit:

Save energy consumption in packaging lines

Challenges:

- Decrease energy consumption in the packaging lines
- Automatic detection of issues in energy supply

Solution:

- Additional sensors to measure pressure and flow data with the capability to maintain minimal air pressures in the line
- Analysis of pneumatic and non-pneumatic data to identify anomalies in the equipment performance and advanced condition monitoring

Predictive Energy in Electronics

Challenges:

- Prevention of energy peaks to save energy cost
- Prediction of energy consumption for the production locations

Industry:

Electronics
(components production)

Benefit:

Reduction of energy consumption

Solution:

- Initial evaluation of energy saving potentials on basis of historical data
- Prediction of energy consumption to pro-actively shutdown energy consumer or to use own energy
- Connection of energy meter at machines and in the fabric
- Learning of patterns (ML model) in energy consumption to predict energy peaks
- Automatic adoption of ML model according to changes in production
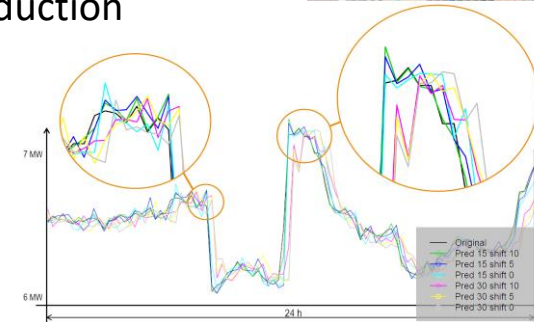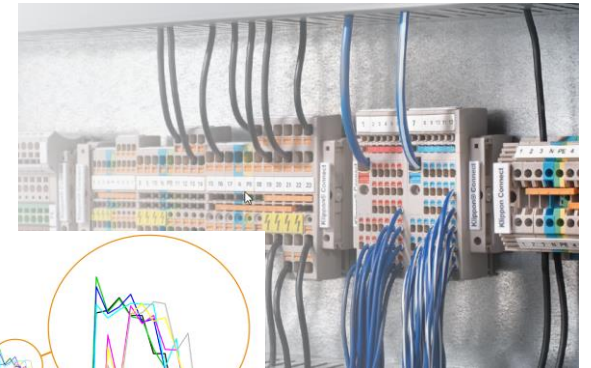
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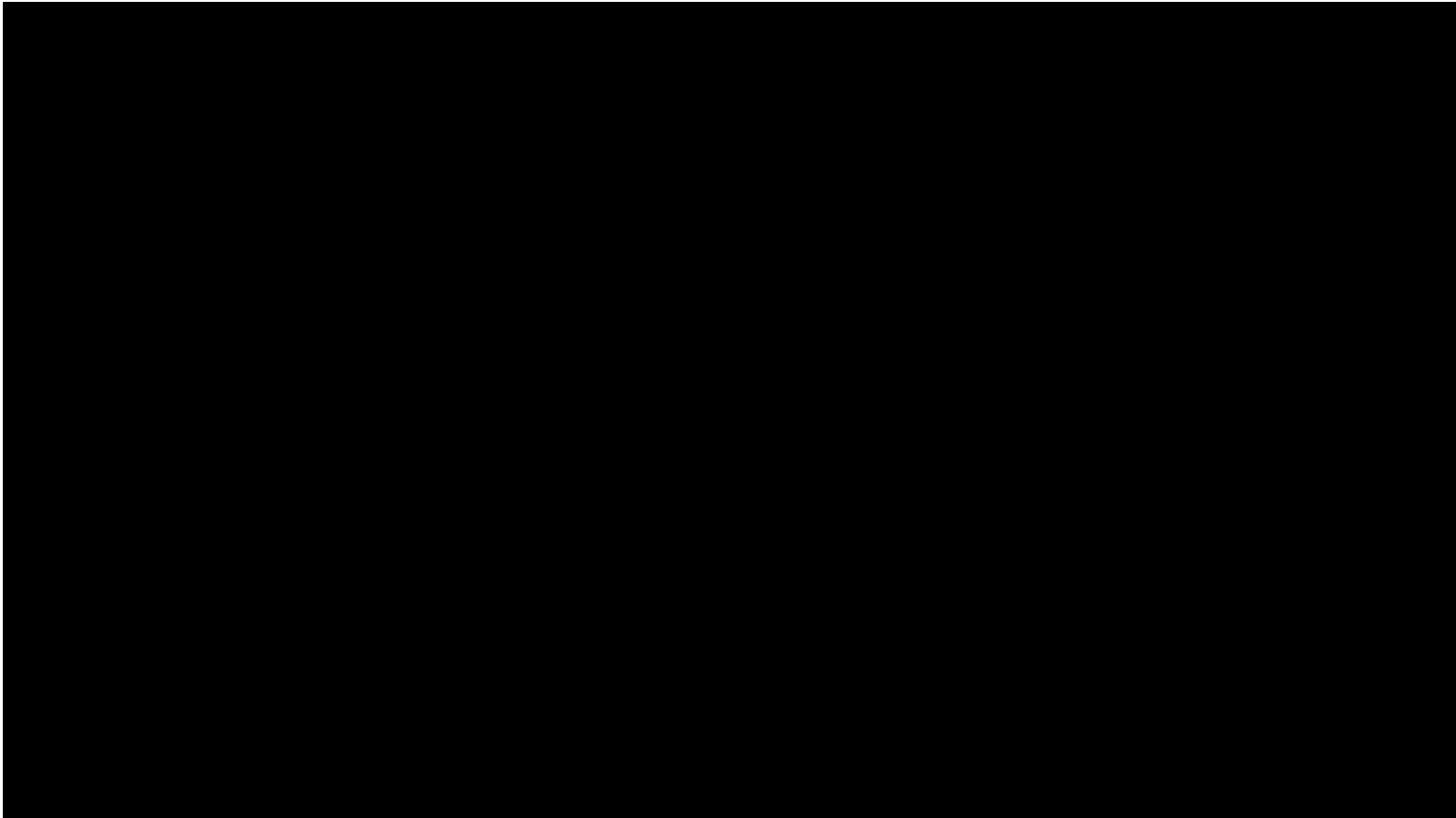
Thank you. Any questions?

Like more information?

Contact details:
jan.koudijzer@festo.com